4. SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

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4. SAFETY STRUCTURES, SYSTEMS, AND COMPONENTS

4.1 Introduction

This chapter provides the details of those facility SSCs that are safety class or safety significant and describes the attributes (such as functional requirements and performance criteria) required to support the safety functions and the subsequent derivation of TSRs.

4.2 Requirements

The following codes, standards, regulations, and DOE orders are specific to this chapter:

- 10 CFR 830, Subpart A, "Quality Assurance Requirements"[1]
- 10 CFR 830, Subpart B, "Safety Basis Requirements"[2]
- DOE Order 420.1A, "Facility Safety"[3]
- DOE-ID Order 420.D, "Requirements and Guidance for Safety Analysis"[4]
- DOE-STD-3009-94, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses"[5]
- DOE-ID AE, "DOE-ID Architectural Engineering Standards."[6]

4.3 Safety-Class Structures, Systems, and Components

The requirements and guidance for safety analyses in DOE-ID Order 420.D[4] define safety class as those SSCs for which responsibility must be taken, either preventive or mitigative, to meet the risk evaluation guidelines for the off-Site public.

The results of the analyses in Chapter 3 for all of the bounding and representative unmitigated accidents show that doses from radioactive materials do not exceed or challenge the risk evaluation guidelines defined in DOE ID Order 420.D for the off-Site public. The analyses for the unmitigated melt expulsion and loss of confinement scenarios show that the evaluation guidelines for the public are challenged or exceeded for some nonradioactive hazardous materials. Therefore, safety-class SSCs are required for ISV operations at the SDA. The following sections discuss the safety-class equipment for ISV operations at the SDA. Table 4-1 is a summary of the safety-class SSCs.

Table 4-1. Summary of safety-class SSCs.

Safety-Class SSC	Safety-Class SSC Basis	Safety Function	Functional Requirements	TSR-Level Controls
Off-gas hood	Failure of the off-gas hood could result in excessive risk to the public.	Provide confinement, thus limiting doses and exposures to the workers and the public from releases.	Perform safety function during all phases of ISV processing, surface and subsurface deflagrations, PC-3 wind and seismic events, and melt expulsions.	System evaluations must be performed to show that the safety function of the off-gas hood can be met prior to ISV operations. The design features are controlled and maintained under the Sitewide configuration control and maintenance programs. An inspection of the off-gas hood will be required.
Off-gas treatment system (Includes primary and secondary off-gas ventilation systems, combustible gas monitors, and backup power supply)	Failure of the off-gas treatment system could result in excessive risk to the public.	Provide off-gas treatment, thus limiting doses and exposures to the workers and the public from releases.	Perform safety function during all phases of ISV processing, surface and subsurface deflagrations, PC-3 wind and seismic events, and melt expulsions.	System evaluations must be performed to show that that the safety function of the off-gas treatment system can be met prior to ISV operations. The design features are controlled and maintained under the Sitewide configuration control and maintenance programs. An inspection of the off-gas treatment system will be required.
Primary and secondary off-gas ventilation systems	Loss of ventilation could result in a deflagration and could result in excessive risk to the public.	Ensure that the combustible gas mixture inside the hood is less than the lower flammability limit (LFL) for the off-gas mixture during normal and abnormal operations.	Operate safely in a combustible gas atmosphere. Operable at high temperatures. Supply dilution of gases. Automatic secondary system. Secondary and primary systems interlocked to the combustible gas monitoring system. Perform safety function during design basis (PC-3) seismic and wind events. Perform safety function during surface and subsurface deflagrations, Perform safety function during melt expulsion events. Perform safety function during and after a loss of primary electrical power.	System evaluations must be performed to show that the safety function of the primary and secondary off-gas ventilation systems can be met prior to ISV operations. The design features are controlled and maintained under the Sitewide configuration control and maintenance programs. An inspection of the primary and secondary off-gas ventilation systems will be required.

Table 4-1. (continued).

Safety-Class SSC	Safety-Class SSC Basis	Safety Function	Functional Requirements	TSR-Level Controls
Backup power supply	Failure of the off-gas treatment system could result in excessive risk to the public.	The primary and secondary off-gas ventilation systems are designated as safety class. Therefore, the backup power supply for these ventilation systems must also be designated as safety class.	Automatic startup upon loss of primary power. Upon loss of primary electrical power, automatically provide sufficient but temporary electrical power to the primary and secondary off-gas ventilation systems, the combustible gas monitoring system, and the toxic gas monitoring system. Provide power for at least 4 hr. Perform safety function during design basis (PC-3) seismic and wind events.	System evaluations must be performed to show that that the safety function of the backup power supply can be met prior to ISV operations. The design features are controlled and maintained under the Sitewide configuration control and maintenance programs. An inspection of the backup power supply will be required.
Combustible gas monitoring system	Failure of the combustible gas monitoring system could lead to a loss of confinement and excessive risk to the public.	The primary and secondary off-gas ventilation systems are designated as safety class due to the presence of combustible gas mixtures that may deflagrate. Therefore, a combustible gas monitor must be provided to monitor the environment in the off-gas hood.	Automatically monitor and report combustible gas concentrations in the hood. Detect potentially hazardous combustible gas mixtures in the off-gas hood. Upon detection alert the operators and initiate automatic action to reduce the off-gas mixture to a safe level. Operable at high temperatures. Safety operated in combustible gas atmospheres. Interlocked to the ventilation systems. Operable during and after the design basis (PC-3) seismic and wind events.	System evaluations must be performed to ensure that the safety function of the combustible gas monitoring system can be met prior to ISV operations. The design features are controlled and maintained under the Sitewide configuration control and maintenance programs. An inspection of the combustible gas monitoring system will be required.

4.3.1 Off-Gas Hood

The following sections discuss the safety function, system description, functional requirements, system evaluation, and controls for the off-gas hood.

4.3.1.1 Safety Function. The results of the accident analysis in Section 3.4 show that the off-gas hood must maintain confinement to protect the public from radioactive and nonradioactive hazardous materials that may be released during normal ISV operations and abnormal operations such as surface and subsurface deflagrations, melt expulsions, and natural phenomena events.

4.3.1.2 System Description. The off-gas hood contains the gaseous effluents from ISV processing, provides a confined area for oxidation of the effluents, and directs the effluents to the off-gas system. The hood measures 60 ft in diameter and is octagonal in shape. A lifting device is located at four of the corners so that the assembled hood can be repositioned. The off-gas hood is constructed of 12-gauge stainless-steel panels and is bolted and gasketed together in a manner that relieves stresses caused by nonuniform thermal expansion. The hood is connected to the off-gas trailer by sections of 12 and 16-in. off-gas line.

4.3.1.3 Functional Requirements. The functional requirements are limited to the requirements that are needed to fulfill the safety function, which in this case is ensuring that the nonradioactive hazardous materials released during normal ISV processing and abnormal events are contained. The following features of the off-gas hood are important to the safety function:

- Electrical components of the off-gas hood shall operate safely in a combustible gas atmosphere
- The off-gas hood shall be operable at temperatures up to at least 1,650°F (900°C)
- The off-gas hood shall be designed to contain surface and subsurface deflagrations
- The off-gas hood shall be capable of performing the safety function during and after a PC-3 seismic event
- The off-gas hood shall be capable of performing the safety function during and after a PC-3 wind event
- The off-gas hood shall be capable of performing the safety function during and after a melt expulsion event.

4.3.1.4 System Evaluation. The off-gas hood will be designed to satisfy the functional requirements of Section 4.3.1.3. System evaluations must be performed to show that the safety function of the off-gas hood can be met prior to ISV operations. During operations, the hood must be inspected to ensure operability. The hood must also receive periodic maintenance and inspection in accordance with the maintenance program.

Verification that the system meets the earthquake, wind, melt expulsion, and deflagration requirements will be performed during design verification and during and after construction through inspections. These verifications ensure that the systems are purchased and constructed in accordance with design requirements. These verifications are performed under the QA program required by 10 CFR 830, Subpart A.

4.3.1.5 Controls (TSRs). An LCO TSR is required to ensure performance of the functional requirements listed in Section 4.3.1.3. Administrative TSRs are required for the Sitewide configuration control and maintenance programs. The design features of the off-gas hood are controlled and maintained under the Sitewide configuration control and maintenance programs. An inspection of the hood will be required.

4.3.2 Off-Gas Treatment System

The following sections discuss the safety function, system description, functional requirements, system evaluation, and controls for the off-gas treatment system.

4.3.2.1 Safety Function. The results of the accident analysis in Section 3.4 show that the off-gas treatment system (includes the primary and secondary off-gas ventilation systems, combustible gas monitors, and backup power supply) must treat the off-gases from ISV processing to protect the public from radioactive and nonradioactive hazardous materials that may be released during normal and abnormal operations such as surface and subsurface deflagrations, melt expulsions, and natural phenomena events.

4.3.2.2 System Description. The off-gas treatment system processes effluents by either trapping the material or by chemically changing the material to a nonhazardous form. An off-gas HEPA prefilter system is employed between the off-gas hood and the off-gas treatment trailer. The HEPA filter units are supported on a structure, which allows for changing of the filters. Differential pressure drop is measured across the HEPA filter housing to monitor solids loading on the filter units.

The off-gas treatment system, which cools, scrubs, and filters the gaseous effluent exhausted from the hood, is contained in the off-gas trailer. The off-gas trailer is enclosed and contains an internal containment module. The containment module houses and isolates the off-gas treatment equipment. The containment module, which is a large glovebox constructed primarily of stainless steel, isolates operators from processing equipment.

The primary components of the off-gas treatment system include: a gas cooler, dual wet scrubber systems with tandem nozzle scrubbers and quenchers, heat exchangers, process scrub tanks, scrub solution pumps, a condenser, three mist eliminators (vane separators), a heater, a dual stage HEPA filter assembly, a blower system, and valves to control the process off-gas path, flow, vacuum, and pressure drop. All valves are specified with fail-safe positions.

The gaseous effluents are drawn through the off-gas system components by an induced draft system. The driving force is provided by a primary blower. A secondary blower rated at least one quarter the capacity of the primary blower is provided in case of failure of the primary blower. The secondary or back-up blower is not designed to pull excess inlet air into the hood, but rather to maintain a negative pressure on the off-gas hood to prevent direct release of effluent until the process can be safely shut down. The backup blower is automatically activated by the process control system when the hood vacuum falls below a preset limit. The exhaust stack on the off-gas treatment system is removable and extends high enough above the off-gas trailer to preclude interference with the HVAC systems for the off-gas treatment trailer and the process control trailer.

4.3.2.3 Functional Requirements. The functional requirements are limited to the requirements that are needed to fulfill the safety function, which in this case, is ensuring that the hazardous materials released during ISV processing are contained and treated. The following features of the off-gas hood are important to the safety function.

- Electrical components of the off-gas treatment system shall operate safely in a combustible gas atmosphere
- The off-gas treatment system shall be operable up to temperatures of at least 1,385°F (750°C)
- The off-gas treatment system shall be designed to contain surface and subsurface deflagrations.
- The off-gas treatment system shall be capable of performing the safety function during and after a PC-3 seismic event
- The off-gas treatment system shall be capable of performing the safety function during and after a PC-3 wind event
- The off-gas treatment system shall be capable of performing the safety function during and after a melt expulsion event.

4.3.2.4 System Evaluation. The off-gas treatment system will be designed to satisfy the functional requirements of Section 4.3.2.3. System evaluations must be performed to show that the safety function of the off-gas treatment system can be met prior to ISV operations. During operations, the system must be inspected to ensure operability. The off-gas system must also receive periodic maintenance and inspection in accordance with the maintenance program.

Verification that the system meets the earthquake, wind, melt expulsion, and deflagration requirements will be performed during design verification and during and after construction through inspections. These verifications ensure that the systems are purchased and constructed in accordance with design requirements. These verifications are performed under the QA program required by 10 CFR 830, Subpart A.

4.3.2.5 Controls (TSRs). An LCO TSR is required to ensure performance of the functional requirements listed in Section 4.3.2.3. Administrative TSRs are required for the Sitewide configuration control and maintenance programs. The design features of the off-gas treatment system are controlled and maintained under the Sitewide configuration control and maintenance programs. An inspection of the off-gas treatment system will be required.

4.3.3 Primary and Secondary Off-Gas Ventilation Systems

The following sections discuss the safety function, system description, functional requirements, system evaluation, and controls for the primary and secondary off-gas ventilation systems.

4.3.3.1 Safety Function. The results of the hazard analysis found that a surface deflagration is possible if the off-gas ventilation systems fail and that the surface deflagration can lead to a loss of confinement. The accident analysis determined that a loss of confinement could result in off-Site exposures above the evaluation guidelines. Therefore, the primary and secondary off-gas ventilation systems are safety class and the safety function of these systems is to ensure that the combustible gas mixture inside the hood is less than the LFL for the off-gas mixture during normal and abnormal operations.

4.3.3.2 System Description. Ventilation is provided by a primary blower. A secondary blower rated at least one quarter the capacity of the primary blower is provided in case of failure of the primary blower. The secondary blower is automatically activated by the process control system when the hood vacuum is reduced below a preset limit.

4.3.3.3 Functional Requirements. The functional requirements are limited to the requirements that are needed to fulfill the safety function, which in this case, is ensuring that combustible gas mixtures in the off-gas hood are less than the LFL_{mix}. Functional requirements are provided for specific accidents or general rationale for which the SSCs are needed. The applicable accidents for these functional requirements are a loss of primary electrical power or a malfunction of the off-gas ventilation system, which allows combustible gases to build up in the off-gas hood and to deflagrate. The following are the functional requirements of the primary and secondary off-gas ventilation systems:

- Electrical components of the primary and secondary off-gas ventilation systems shall operate safely in a combustible gas atmosphere
- The primary and secondary ventilation systems shall be operable up to temperatures of at least 212°F (100°C)
- The primary and secondary off-gas ventilation systems shall provide sufficient flow to ensure that the combustible gas mixture is less than 25% of the LFLmix of 3.7%
- The primary and secondary ventilation systems shall be interlocked such that the secondary system will automatically start if the primary system fails
- The primary and secondary ventilation systems shall be interlocked with the combustible gas monitor such that if combustible gas concentrations are greater than 25% of the LFL mix, the dilution of the system is increased automatically by increasing the flow volume rate provided by the primary and/or secondary systems
- The primary and secondary ventilation systems shall be capable of performing the applicable safety functions during and after a PC-3 seismic event and a PC-3 wind event
- The primary and secondary ventilation systems shall be capable of performing the applicable safety functions during and after melt expulsion events
- The primary and secondary ventilation systems shall be capable of performing the applicable safety functions during and after a loss of primary electrical power.

4.3.3.4 System Evaluation. The following are the system evaluations that will be performed to ensure that the safety-class SSC will perform the applicable safety function:

- The operability of the system fans will be evaluated by pre-ISV maintenance and inspections and by running the fans to ensure that they will operate and provide sufficient flow
- The operability of the interlock between the primary and secondary fans will be checked prior to ISV operations by ensuring that the secondary fan automatically operates when the primary fan is manually shut down or when flow from the primary fan is manually reduced to the interlock trip point
- The interlock between the combustible gas monitor and the primary and secondary fans will be evaluated prior to ISV operations by operating the fans one at a time and feeding the monitor a test gas composition that would exceed the interlock trip point

- The operability of the backup power supply and interlock system after and during a seismic event shall be determined by engineering analyses completed prior to ISV operations

- During operations, the systems must be inspected to ensure operability, and receive periodic maintenance and inspection in accordance with the maintenance program

- Verification that the system meets the earthquake, wind, melt expulsion, and deflagration requirements will be performed during design verification and during and after construction through inspections. These verifications ensure that the systems are purchased and constructed in accordance with design requirements. These verifications are performed under the QA program required by 10 CFR 830, Subpart A.

4.3.3.5 Controls (TSRs). An LCO TSR is required to ensure performance of the functional requirements listed in Section 4.3.3.3. Administrative TSRs are required for the Sitewide configuration control and maintenance programs. The design features of the systems are controlled and maintained under the Sitewide configuration control and maintenance programs. An inspection of the systems will be required.

4.3.4 Backup Power Supply

The following sections discuss the safety function, system description, functional requirements, system evaluation, and controls for the backup power supply.

4.3.4.1 Safety Function. The primary and secondary off-gas ventilation systems and the combustible gas monitor are designated as safety class. Therefore, the backup power supply for these systems must also be designated as safety class. The safety function of the backup power supply is to automatically provide sufficient, but temporary electrical power to the primary and secondary off-gas ventilation systems and to the combustible gas monitoring system to allow them to perform safety functions upon loss of primary electrical power.

4.3.4.2 System Description. Primary electrical power is provided by the INEEL and RWMC power systems (see description in main body of the RWMC SAR). If line power is interrupted to the Site, a transfer switch in the motor control center will automatically activate the backup power supply. This system will provide temporary power to all off-gas systems and ancillary components to maintain off-gas collection, treatment, and process control. The backup power supply does not supply power for melting.

4.3.4.3 Functional Requirements. The functional requirements are limited to the requirements that are needed to fulfill the safety function. Functional requirements are provided for specific accidents or general rationale for which the SSCs are needed. The applicable accidents for these functional requirements are a mechanical failure or a natural event that results in a loss of primary electrical power to the primary and secondary off-gas ventilation systems and the combustible gas monitor system. The following are the functional requirements of the backup power supply:

- The backup power supply shall meet the requirements specified in the NEC, NFPA 10, and DOE-ID AE standards

- The backup power supply shall be interlocked to the primary power system such that the generator will automatically start within three seconds, once primary power is lost

- The backup power supply shall be capable of providing temporary electrical power to at least the primary and secondary ventilation systems and the combustible gas monitor and shall allow these systems to operate at full capacity

- The backup power supply shall be capable of providing continuous temporary electrical power for at least 4 hr after a loss of primary power event

- The backup power supply shall be capable of full operation during and after a PC-3 seismic event and a PC-3 wind event

- During operations, the backup power supply must be inspected to ensure operability. The systems must also receive periodic maintenance and inspection in accordance with the maintenance program.

4.3.4.4 System Evaluation. The following are the system evaluations that will be performed to ensure that the safety-class SSC will perform the applicable safety function:

- The operability of the backup power supply will be evaluated by pre-ISV maintenance and inspections and by operating the generator to ensure that it will provide sufficient temporary electrical power to allow the primary and secondary ventilation systems and the combustible gas monitor to perform the applicable safety functions during a loss of primary power event

- The operability of the interlock system between the backup power supply and the primary and secondary ventilation system and the combustible gas monitoring system will be checked prior to ISV operations by ensuring that the backup power supply automatically operates within the required time limits when the primary power is manually shut off

- The operability of the backup power supply and interlock system after and during a seismic or wind event shall be determined by engineering analyses completed prior to ISV operations.

4.3.4.5 Controls (TSRs). An LCO TSR is required to ensure performance of the functional requirements listed in Section 4.3.4.3. Administrative TSRs are required for the Sitewide configuration control and maintenance programs. The design features of the system are controlled and maintained under the Sitewide configuration control and maintenance programs. An inspection of the system will be required.

4.3.5 Combustible Gas Monitoring System

The following sections discuss the safety function, system description, functional requirements, system evaluation, and controls for the combustible gas monitoring system.

4.3.5.1 Safety Function. The primary and secondary off-gas ventilation systems are designated as safety class, due to the presence of combustible gas mixtures that may deflagrate. Therefore, a combustible gas monitor must be provided to monitor the environment in the off-gas hood. The safety function of the combustible gas monitoring system is to detect potentially hazardous combustible gas mixtures in the off-gas hood, and upon detection, alert the operators and initiate automatic action to reduce the off-gas mixture to a noncombustible level.

4.3.5.2 System Description. A combustible gas-monitoring instrument in the off-gas hood should be included in the design. A description of this instrument will be provided when it is available. It is assumed that the system will be commercially available.

4.3.5.3 Functional Requirements. The functional requirements are limited to the requirements that are needed to fulfill the safety function and are applicable to the accident scenarios. The applicable accidents for these functional requirements are a loss of primary electrical power or a malfunction of the off-gas ventilation system, which allows combustible gases to build up in the off-gas hood and deflagrate. The following are the functional requirements of the combustible gas monitoring system:

- The combustible gas monitoring system shall automatically and in real time monitor the combustible gas mixture in the off-gas hood and shall provide immediate audible and visual alarms at the operator station when the combustible gas concentration in the hood is equal to or greater than 25% of the LFL_{mix} of 3.7%

- Components of the monitoring system that are directly exposed to the off-gases shall be operable up to temperatures of at least 212°F (100°C)

- Portions of the monitoring system that are directly exposed to the off-gases shall be rated as an NEC Class I, Division I instrument

- The combustible gas monitor shall be serviced by the backup power supply upon loss of primary power

- The primary and secondary ventilation systems shall be interlocked with the combustible gas monitor such that if combustible gas concentrations are greater than 25% of the LFL_{mix} the dilution of the system is increased automatically by increasing the flow volume rate provided by the primary and/or secondary systems

- The monitoring system shall be capable of full operation during and after a PC-3 seismic event or a PC-3 wind event.

4.3.5.4 System Evaluation. The following are the system evaluations that will be performed to ensure that the safety-class SSC will perform the applicable safety function:

- The operability of the monitoring system will be evaluated by pre-ISV maintenance and inspections that will include feeding the system a test gas composition that would exceed its interlock and alarm trip points

- The interlock between the combustible gas monitor and the primary and secondary fans will be evaluated prior to ISV operations by operating the fans one at a time and feeding the monitor a test gas composition that would exceed its interlock trip point

- The operability of the monitoring system after and during a seismic or wind event shall be determined by engineering analyses completed prior to ISV operations

- During operations, the system must be inspected to ensure operability. The system must also receive periodic maintenance and inspection in accordance with the maintenance program.

4.3.5.5 Controls (TSRs). An LCO TSR is required to ensure performance of the functional requirements listed in Section 4.3.5.3. Administrative TSRs are required for the Sitewide configuration control and maintenance programs. The design features of the system are controlled and maintained under the Sitewide configuration control and maintenance programs. An inspection of the system will be required.

4.4 Safety-Significant Structures, Systems, and Components

The requirements and guidance for safety analysis defines safety-significant SSCs as those SSCs (not designated as safety class) that prevent or mitigate postulated abnormal scenarios in the anticipated or unlikely frequency range that could result in consequences to facility and co-located workers as follows:

- Total effective dose equivalent more than 25 rem
- Exposure to life-threatening concentrations of hazardous chemicals (greater than ERPG-3 levels)
- Exposure to explosion overpressures causing serious injury (greater than 10 psi).

In cases where postulated accidents meet these criteria and additional barriers are needed to achieve acceptable risk, safety-significant SSCs may be identified. The following sections discuss the safety-significant equipment for ISV operations at the SDA. Table 4-2 is a summary of the safety-significant SSCs.

4.4.1 Toxic Gas Monitoring System

The following sections discuss the safety function, system description, functional requirements, system evaluation, and controls for the toxic gas monitoring system.

4.4.1.1 Safety Function. The results of the hazard analysis show that the emissions of toxic materials from an underground fire can reach concentrations that may be hazardous to the workers.

4.4.1.2 System Description. Toxic gas monitoring systems are placed around the periphery of the off-gas hood and in occupied areas.

4.4.1.3 Functional Requirements. The functional requirements are limited to detecting concentrations of hazardous materials that may threaten the health and safety of the workers and then sounding an alarm. At a minimum, the system shall be capable of detecting in real time, concentrations of phosgene, hydrochloric acid, carbon tetrachloride, carbon monoxide, cadmium, and mercury. The toxic gas monitors shall be operable during and after design basis (PC-2) seismic and wind events.

4.4.1.4 System Evaluation. The following are the system evaluations that will be performed to ensure that the safety-significant SSC will perform the applicable safety function:

- The operability of the toxic gas monitoring system will be checked to ensure that the system is operational prior to commencing ISV processing
- During operations, the system must be inspected to ensure operability. The system must also receive periodic maintenance and inspection in accordance with the maintenance program.

4.4.1.5 Controls (TSRs). An LCO TSR is required to ensure performance of the functional requirements listed in Section 4.4.1.3. Administrative TSRs are required for the Sitewide configuration control and maintenance programs. The design features of the system are controlled and maintained under the Sitewide configuration control and maintenance programs. An inspection of the system will be required.

Table 4-2. Summary of safety-significant SSCs.

Safety-Significant SSC	Safety-Significant SSC Basis	Safety Function	Functional Requirements	TSR Controls
Toxic gas monitoring system	An underground fire could expose workers to hazardous concentrations of nonradioactive hazardous materials.	Ensure that the concentration of nonradioactive hazardous materials remains below guidelines.	Detect and warn of hazardous concentrations of nonradioactive hazardous materials. Operable during and after the design basis (PC-2) seismic and wind events.	System evaluations must be performed to ensure that the safety function of the toxic gas monitoring system can be met prior to ISV operations. Design features of the system are controlled and maintained under the Sitewide configuration control and maintenance programs. An inspection of the system will be required.
Propane delivery system	A propane tank BLEVE or fuel-air explosion could expose workers to overpressures greater than 10 psi or could expose the workers to hazardous concentrations of nonradioactive hazardous materials when the BLEVE or fuel-air explosion initiate a failure in the off-gas hood or the off-gas treatment system.	Ensure that the propane delivery system is designed to prevent a BLEVE or fuel-air explosion.	System designed to meet requirements of NFPA 58. Perform safety function during design basis (PC-2) seismic and wind events.	System evaluations must be performed to ensure that the safety function of the propane delivery system can be met prior to ISV operations. Design features of the system are controlled and maintained under the Sitewide configuration control and maintenance programs. An inspection of the system will be required.

4.4.2 Propane Delivery System Design

The following sections discuss the safety function, system description, functional requirements, system evaluation, and controls for the propane delivery system design.

4.4.2.1 Safety Function. The results of the hazard analysis show that a BLEVE or fuel-air explosion involving the propane delivery system may be hazardous to the facility and co-located workers.

4.4.2.2 System Description. The propane delivery system consists of the propane tank and the piping for delivering propane to the off-gas treatment system.

4.4.2.3 Functional Requirements. The functional requirements are limited to designing the system to meet requirements of NFPA 58. The system shall be designed to prevent a fire, a BLEVE, and a fuel-air explosion during design basis (PC-2) seismic and wind events.

4.4.2.4 System Evaluation. The following are the system evaluations that will be performed to ensure that the safety-significant SSC will perform the applicable safety function:

- During operations, the system must be inspected to ensure operability. The system must also receive periodic maintenance and inspection in accordance with the maintenance program.

4.4.2.5 Controls (TSRs). An LCO TSR is required to ensure performance of the functional requirements listed in Section 4.4.2.3. Administrative TSRs are required for the Sitewide configuration control and maintenance programs. The design features of the system are controlled and maintained under the Sitewide configuration control and maintenance programs. An inspection of the system will be required.

4.5 References

1. 10 CFR 830, Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*, Office of the Federal Register, February 4, 2002.

2. 10 CFR 830, Subpart B, "Safety Basis Requirements," *Code of Federal Regulations*, Office of the Federal Register, February 4, 2002.

3. DOE Order 420.1A, "Facility Safety," U.S. Department of Energy, May 20, 2002.

4. DOE-ID Order 420.D, "Requirements and Guidance for Safety Analysis," U.S. Department of Energy Idaho Operations Office, July 17, 2000.

5. DOE-STD-3009-94, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses," U.S. Department of Energy, July 1994 (including Change 2, April 2002).

6. DOE-ID AE, "DOE-ID Architectural Engineering Standards," U.S. Department of Energy Idaho Operations Office, Rev. 29, September 2002.

5. DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

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5. DERIVATION OF TECHNICAL SAFETY REQUIREMENTS

5.1 Introduction

This chapter summarizes the potential controls for ISV operations in the SDA based on the information in Chapter 3, "Hazard and Accident Analyses;" Chapter 4, "Safety Structures, Systems, and Components;" and Chapter 6, "Criticality Protection." The TSR controls are to be fully developed in the final DSA, along with a separate TSR document.

Administrative controls for implementation of radiation protection, hazardous material protection, industrial safety, and QA programs are not included in the general administrative controls, because requirements to develop and implement safety programs at nuclear facilities are given in the CFRs, as described in TSR-100.[1]

TSR-level safety limits and the associated limiting control settings, and limiting conditions for operations may potentially be required for the following:

- Off-gas hood
- Off-gas treatment system (includes primary and secondary off-gas ventilation systems and combustible gas monitoring systems)
- Primary and secondary off-gas ventilation systems
- Backup power supply
- Combustible gas monitoring system
- Toxic gas monitoring system.

TSR-level administrative controls may potentially be required for the following:

- Emergency preparedness program
- Procedures and training
- Remote ISV operations
- Exclusion zone
- Controlled access to the off-gas hood and operating areas near the hood
- Monitoring for toxic gas around the periphery of the off-gas hood and in occupied areas
- Minimum staffing for ISV operations
- Hoisting and rigging program
- Maintenance and inspection program

- Fire protection program
- Maintenance of overburden thickness.[a]

5.2 Reference

1. TSR-100, "INEEL Standardized Technical Safety Requirements (TSR) Document," Current revision.

a. A 10-cm overburden thickness is assumed in the accident analyses of Section 3.4.

6. CRITICALITY PROTECTION

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6. CRITICALITY PROTECTION

6.1 Introduction

This chapter describes the facility-specific criticality safety and protection program delineating requirements for criticality control and its implementation. The criticality safety program ensures that sufficient controls are in place to reduce the likelihood and to mitigate the consequences of inadvertent nuclear criticality excursions.

6.2 Requirements

The design codes, standards, regulations, and DOE orders that apply to the criticality safety program are contained in the following documents:

- DOE Order 232.1A, "Occurrence Reporting and Processing of Operations Information"[1]
- DOE Order 420.1A, "Facility Safety,"[2] (Section 4.3 only)
- DOE Order 5480.20A, "Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities"[3]
- ANSI/ANS 8.20, "Nuclear Criticality Safety Training."[4]

6.3 Criticality Concerns

6.3.1 Criticality Safety Principles and Criteria

The fundamental requirement for criticality safety is that before a new operation with fissionable materials is begun, or before an existing operation is changed, it shall be determined that the entire process will be subcritical under both normal and credible abnormal conditions.[5]

Criticality safety analysis is performed by evaluating fissile systems (normal and abnormal conditions) and comparing them against established acceptance criteria. The basic criteria are:

Application of the double-contingency principle to determine limits of operation: The double-contingency principle recommends that sufficient factors of safety be incorporated into design or procedures to require at least two unlikely, independent, and concurrent changes in process conditions (parameters) before a criticality accident is possible. No single failure shall result in the potential for a criticality accident. When controls cannot be applied to multiple independent parameters, a system of multiple controls on a single parameter is allowed. The number of controls required for a single controlled process parameter shall be based on reliability and any features (such as shielding) that minimize the impact of failure.

The double-contingency principle is applied to all credible criticality accident scenarios in determining the required design features and administrative controls to prevent an inadvertent criticality.

Passive engineered control (such as geometry control) is the preferred control method. Where passive engineered control is not feasible, the preferred order of controls is active engineered controls followed by administrative controls.

A maximum calculated k-eff of 0.95 after a single failure: When reliance is based on analytic methods, rather than accepted experimental or handbook data, the calculated k_{eff} must include the uncertainties of the calculational method and consider the effects of credible accidents, corrosion, and tolerances.

The hazard analysis in Section 3.3 of this document identifies nuclear criticality as a potential hazard during ISV operations. The ISV treatment area contains many times the minimum critical mass of fissile material. However, the fissile materials in the buried wastes occur mainly as contaminates at low concentrations. The evaluation[6] in Section 6.3.2 examines criticality safety issues associated with using ISV as a means of immobilizing the fissile material. For the criticality safety evaluation, only Pu-239 and not the uranium isotopes are included, since Pu-239 is by far the most reactive and abundant fissile material in the waste buried at the SDA.

6.3.2 Criticality Safety Evaluation

For criticality to occur in the SDA due to the ISV process, several unlikely concurrent parameters must exist. There must be sufficient fissile mass; the fissile mass must be at or near the optimum concentration; the fissile mass must be in a near optimal geometry; near optimal reflection; and the fissile mass must be in a waste matrix that lacks diluent and neutronic absorber. The ISV process will remove and eventually exclude moderating materials from the vitrified matrix.

Various configurations were evaluated to determine if any criticality concerns arise in conjunction with treating the buried waste contained in the SDA with the ISV process. The evaluation[6] consisted of three phases. The first phase was to consider criticality scenarios during the initial application of the ISV process. The second phase consisted of evaluating the final configurations as a result of the application of the ISV process. The third phase was to address ancillary issues relating to ISV and criticality safety. Each of these phases is further described in the remainder of this section.

During the initial application of the ISV process, the fissile-bearing waste within the SDA is subjected to various physical and mechanical processes prior to the eventual vitrification of the waste matrices. These physical and mechanical processes include the melting of metals, the oxidation of metals, the melting of plastics that could entrain fissile material, subsidence in the waste zone, creation of convective currents in the melt zones that will disperse the fissile material, and the eventual formation of vitrified waste materials.

These physical and mechanical processes lead to the development of the scenarios and final configurations that will be evaluated in the first phase. Two postulated scenarios that could lead to an unsafe condition will be evaluated. The first scenario is the melting and eventual reconfiguration of fissile material in the form of molten metal in an unsafe configuration. The second scenario being the formation of an unsafe condition due to fissile material becoming entrained in or mixed with plastic and forming an unsafe condition prior to the eventual removal of the plastics due to the ISV process.

The second phase evaluates the final configuration. This second phase will consist of three parts. The first part is the determination of the fissile concentration necessary to achieve an unsafe configuration in a large vitrified soil block. The second part is the comparison of the reactivity between vitrified soil and water saturated soil in order to show that once the waste matrices are vitrified, a higher concentration is necessary to achieve an unsafe condition. The third part is to evaluate the localized effects of an overloaded drum becoming vitrified in the presence of other fissile-bearing waste materials.

The third phase of this evaluation will address the effects of a postulated melt expulsion, re-entry of water into the final configuration, and whether it is credible, from a criticality-safety standpoint, to form an unsafe condition in the off-gas collection system.

6.3.2.1 Criticality Scenarios During Application of ISV. During the application of the ISV process the waste will undergo physical changes. The possibility of these physical changes to cause the formation of a critical system during the ISV process is addressed here. Two scenarios are addressed. The formation of a critical system due to the melting and concentration of fissile materials in the form of metal and the formation of a critical system due to the combination of fissile material and polyethylene.

6.3.2.1.1 Melting and Concentration of Fissile Material in Metal Form—One postulated scenario of concern is the melting of fissile material during the application of the ISV process and the formation of a critical configuration.

The nature of plutonium metal is to readily oxidize in air. Therefore, metal pieces within the SDA are in most likelihood completely oxidized. Calculations of oxidation rate due to water for 1,200 g of Pu-239 metal as a single sphere in a drum show that after 27 years not all of the metal would be oxidized.[6] However, if it were divided into many pieces, it would be. In addition, the assumption of a spherical shape with minimum surface area is overly conservative. Flat shapes have more surface area, division of the material into more than one piece increases surface area, and most of the material was in the form of contamination (that is, finely divided). The oxide is very stable.

The oxidation potentials are sufficiently high that ISV will not result in reduction of the oxides to a metal form. The oxide is generally an insoluble form and will be made more insoluble by heating processes such as ISV. The fissile material is distributed in relatively low concentrations throughout he SDA. If some melting of nonoxidized metal pieces did occur, it would occur on relatively small quantities of fissile material. No credible concentration mechanism for a large amount of fissile material has been identified.

Based upon these facts, the formation of a critical system due to the melting and concentration of plutonium metal within the waste matrices of the SDA is not credible.

6.3.2.1.2 Moderation of Fissile Material by Mixing with Organic Material—Next, consider the combination of plutonium and polyethylene postulated configurations regarding the ISV process and what physically happens to the waste matrices within the SDA. During the ISV process, the temperatures are high enough to drive off organic compounds such as polyethylene and also any liquids in the waste melt zone. Most of the waste contained in the melt zone will melt and/or vaporize at the respective melting and vaporization points. Out of the waste matrices present, the most reactive waste form would be polyethylene, when combined with plutonium.[6]

Calculational models evaluated 1,200 g of PuO_2 combined with polyethylene in two configurations. The first configuration modeled a single 55-gal drum containing 65.1% porous PuO_2 (4 g/cc) with polyethylene filling the pores, in the form of a slab at the bottom of the drum. This was done to address a localized accumulation of fissile material intermixing with polyethylene within a 55-gal drum or a localized area in the waste zone, as a result of the application of the ISV process. In reality, the PuO_2 would be mixed with other waste materials. The result was $k_{eff} + 2\sigma = 0.397$. The next model evaluated 65.1% porous PuO_2 with polyethylene in the pores and with the polyethylene impregnated oxide in the shape of a sphere. The result was $k_{eff} + 2\sigma = 0.564$.

These models are conservative and enveloping for the expected configurations within the waste.[6] Therefore, the formation of a critical system through the combination of PuO_2 and polyethylene is not credible with the expected fissile masses and waste combinations, due to the application of the ISV process.

6.3.2.2 *Criticality Scenarios Related to the Final Vitrified Configuration.* The vitrification process produces a large block of vitrified material. This large vitrified block will replace the current waste zone. The process of ISV will set up convective currents within the melt zone that will disperse the fissile material in a homogenous manner throughout the melt zone and eventually the vitrified matrix. The purpose of this section is to address the criticality safety of the vitrified matrix. Various-sized vitrified blocks along with combinations of localized vitrified materials and various compositions representing the vitrified matrix, were evaluated to determine the point at which an unsafe condition occurs. Additionally, a comparison is made between systems comprised of fissile material dispersed in a vitrified matrix, versus those where fissile material is dispersed in a saturated soil matrix.

6.3.2.2.1 Distribution of Plutonium in a Vitrified Matrix – Slab Configuration—To address the final vitrified configuration a series of slab problems were thus studied, assuming the soil to contain approximately 70.1 wt% SiO_2 (the actual analysis after ignoring trace materials), 80 wt% SiO_2, 90 wt% SiO_2, or pure silica. The slabs were evaluated as either 10 or 14 ft thick and as either infinite in the horizontal directions or finite.

In each of the cases the vitrified slabs were reflected. The bottom reflector was modeled as vitrified soil, with the top reflector modeled as noncompacted soil. In the finite cases, the horizontal surfaces were also reflected by 70.1 wt% SiO_2 vitrified soil.

The models that were evaluated as infinite in the horizontal directions yielded the minimum concentrations associated with an unsafe condition. The models that were evaluated as finite in all directions yielded a concentration and an associated unsafe mass.

For the infinite slab cases, (14 ft in depth), it was shown that 2.0 g Pu/l with actual soil (70.1 wt% silica) would be subcritical with a $k_{eff} + 2\sigma = 0.873$. For a similar system composed of pure silica (100 wt% SiO_2), a concentration of 1.0 g Pu/l yields a subcritical system with a $k_{eff} + 2\sigma = 0.934$.[6] Applying these conservative concentrations to finite systems (30 × 30 × 14 ft deep slab), it is shown that the corresponding amounts of 357 kg of Pu would be subcritical for a 100% pure SiO_2 system, and 714 kg of Pu for a 70.1 wt% SiO_2 system. This amount of fissile material in such a localized area is well beyond a reasonable expected amount.

For the finite cases it was shown that for a 30 × 30 × 14-ft slab that is fully reflected, a fissile concentration of 2.5 g/L in the normal vitrified soil (70.1 wt% silica) was safely subcritical ($k_{eff} + 2\sigma = 0.941$). The amount of fissile mass associated with this configuration was 892 kg of plutonium in the vitrified block.[6]

The fissile masses necessary to formulate an unsafe condition in a vitrified matrix are not credible.

6.3.2.2.2 Comparison of Pu in a Vitrified Matrix and Water Saturated Matrix—The slab configurations evaluated and analyzed plutonium at various concentrations within a large homogeneous block of vitrified material. A set of calculational models was developed to compare the reactivity effects between PuO_2 dispersed in vitrified soil or water-saturated soil. These models included an evaluation of higher localized fissile masses in optimum spherical geometric configurations. The purpose of this set of calculations is to show the decrease in reactivity between like systems due to the application of the ISV process, as opposed to no treatment and the possibility of future water in-leakage into the waste zone. Additionally, these cases help address questions relating to the formation of localized pockets of vitrified materials and containing higher concentrations of fissile material.

Studies were made using the MCNP code to calculate k_{eff} for a range of Pu-239 concentrations in a mixture contained in a sphere and fully reflected.[6] Initial studies were made for single spheres containing a mixture of either Pu-239 O_2 and vitrified soil, or Pu-239 O_2 and water-saturated nominal soil (SDA soil has a porosity of 40%). The maximum calculated $k_{eff} + 2\sigma$ for spheres with a mass of 1,200 g Pu mixed was shown to be 0.487 for vitrified soil or 0.935 for Pu in water-saturated soil. In all of these cases the medium surrounding the spheres was five feet of 40% porous water-saturated soil. As shown by these cases, the saturated soil was much more reactive.

Calculational models were then evaluated that consisted of an $11 \times 11 \times 3$ array of drums each containing fissile material distributed in a vitrified matrix or water saturated soil. The fissile loading in the four center drums was modeled as 1,200, 300, 300, and 300 g of plutonium in the form of PuO_2. The remaining drums in the array were modeled as containing 200 g of plutonium distributed in the respective matrices.

The premise of the ISV process is that a uniform melt occurs in the waste zone as it grows outward. The purpose of this set of cases was to evaluate the reactivity associated with postulated localized vitrification in over loaded drums based on past retrieval history. It is expected that most buried drums lack integrity. These cases assume the drums are intact to provide a basis to evaluate ordered arrays of vitrified localized pockets of fissile material. This will address any concerns associated with localized vitrification and the failure of the convective currents to adequately disperse the fissile material into the melt matrix.

The drums were modeled as cuboids in which the height of the drum was preserved, with the horizontal dimensions of the modeled cuboid equivalent to the original diameter of the drum. This cuboid arrangement allowed for a densely packed array of drums to be evaluated. Initial drum disposal operations called for the placement of drums into the trenches in a neat orderly array. In order to keep radiation doses to personnel as low as reasonably achievable (ALARA), the drums were eventually dumped randomly into the pit. In the cases where drums were stacked, degradation of the drum material due to the burial timeframes would lead to similar conditions as those when the drums were just dumped into the burial pits. A conservative configuration, such as a stacked regular array, gives a tighter packing fraction than the more expected actual configuration. The actual waste configuration will have soil intermixed with the waste. The area of the model is approximately 20×20 ft. In the center of the array in the central plane, the four overloaded drums were located adjacent to each other.

The maximum calculated $k_{eff} + 2\sigma$ for the drum array cases was shown to be 0.500 for fissile material distributed in a vitrified soil, with a vitrified soil reflector. For fissile material distributed in a vitrified soil with a saturated soil reflector, it was 0.548. For fissile material distributed in water-saturated soil, with a water-saturated soil reflector it was 0.955. Each of these configurations is very conservative, since any neutron absorbing/diluent materials in the waste forms were ignored. Additionally, the geometrical configurations were optimized as spheres and the fissile loading per overloaded drums was in excess of expected mass that exists as localized systems in the SDA.

These cases show that the formation of an unsafe condition due to localized higher concentrations of fissile material and localized vitrification is not credible.

6.3.2.3 Ancillary Criticality Safety Issues. The effects of a postulated melt expulsion, reentry of water into the final configuration, and whether it is credible, from a criticality safety standpoint, to form an unsafe condition in the off-gas collection system are addressed in the following sections.

6.3.2.3.1 Melt Expulsion—The possibility of a melt expulsion and any criticality implications need to be addressed as part of this overall evaluation of the ISV process. A melt expulsion is a possible upset condition from the heating of a volatile chemical or creating a steam pocket in the waste zone, resulting in an expulsion of material out of the waste area. The safety concern in melt expulsion is the scattering of radioactive material and damage to equipment rather than criticality. Any melt expulsion would dissipate and disperse the fissile material, thus decreasing its concentration and the reactivity of the system. There are no criticality concerns related to melt expulsion.

6.3.2.3.2 Flooding and/or Water Re-entry—The concern of flooding or water reentry into the SDA following the ISV application will be discussed here. The issue that needs to be addressed is whether the application of the ISV process increases the probability for the formation of a critical system within the vitrified matrix, as opposed to water intrusion into the current waste configuration.

In the case of ISV, there would not be sufficient void volume in the final vitrified material for intrusion of extra water such that it would be intimately mixed with the entrained fissile material. As previously discussed, the ISV process will form a melt that will disperse the fissile material, as opposed to concentrating it. Even if some water were to enter the vitrified matrix it would be still be less reactive than if it were to enter the waste zone prior to the application of ISV. Therefore, the formation of a critical system due to flooding is not possible after the application of the ISV process.

6.3.2.3.3 Collection of Fissile Materials in the Off-Gas System—The off-gas collection system consists of three parts, including the off-gas hood, a HEPA prefilter system and the off-gas treatment system. The off-gas treatment hood contains the gaseous effluents from ISV processing, provides a confined area for oxidation of the effluents, and directs the effluents to the off-gas system (see description in Chapter 2).

Accumulation of sufficient fissile material in the off-gas system to cause a criticality event is not credible. The subsurface nature of ISV is such that most of the fissile material is contained and incorporated in the melt zone itself (approximately 99.9% in the melt, with the remaining fraction contained mostly in the overburden).[6] The amount of plutonium that migrates from the melt and through the overburden will not be significant.

Due to the HEPA filtration and the low expected amount of fissile material that will make it to the off-gas system, a criticality accident is not credible.

6.3.3 Criticality Safety Analysis

It is extremely unlikely that the maximum drum loading analyzed would be encountered in the area to be treated. The analyzed configurations producing the largest reactivity are not possible. They require the material in a drum to somehow be scavenged into a spherical shape and intimately mixed with water-saturated soil. The array problems require such scavenged spheres in four adjacent drums to be located physically in contact with each other. ISV would remove the drums, and cause enough mixing to prevent the hypothetical spheres from forming. The most reactive scenarios are physically impossible to attain with ISV. Both of these would cook off any water intimately mixed in the hypothetical spheres of Pu and soil mix. None of the scenarios incorporated the ^{10}B from the naturally occurring boron in the soil.

6.4 Criticality Controls

This section summarizes information relevant to criticality control for ISV operations.

6.4.1 Engineering Controls

Based on the results of the analysis for ISV operations, an inadvertent criticality is deemed incredible and no engineering controls are required.

6.4.2 Administrative Controls

Based on the results of the analysis for ISV operations, an inadvertent criticality is deemed incredible and no administrative controls are required.

6.4.3 Application of Double-Contingency Principle

Satisfying the double-contingency principle requires that at least more than one unlikely, independent, and concurrent change in process conditions would be necessary before a criticality accident is possible. No independent failures are identified that can lead to an inadvertent criticality.

6.5 Criticality Protection Program

The INEEL criticality safety program provides the requirements for processes that involve retrieval, handling, and storage of fissionable material. This program is based on applicable standards as identified in current contractual requirements and implemented by appropriate INEEL policies, standards, and procedures. The INEEL has implemented an approved nuclear criticality safety program[7] that is in accordance with DOE Order 420.1A. The criticality safety program is followed for all project activities to ensure that fissile material is handled in such a way that a criticality accident is prevented and mitigated.

6.5.1 Criticality Safety Organization

The INEEL Criticality Safety Program implements DOE Order 420.1A, which applies to fissile materials that pose a criticality accident hazard.[7] The program implements controls for fissile materials that are produced, processed, stored, transferred, disposed of, or otherwise handled to ensure that the probability of a criticality accident is acceptably low. The program ensures, to the extent practicable, that the public, the workers, property (both government and private), the environment, and essential operations are protected from the effects of a criticality accident. The nuclear operations facility management is responsible for establishing the criticality safety program. The criticality safety staff provides technical support for the criticality safety program. This includes documenting the requirements and recommendations of the criticality safety program and performing criticality safety evaluations and reviews to support facility safety analyses. Facility management is responsible for safe operations at facilities containing fissile material. Additional specific criticality safety responsibilities of nuclear operations management, facility management, and the criticality safety staff are identified in Program Requirements Document (PRD)-112.[7]

6.5.2 Criticality Safety Plans and Procedures

The criticality safety program has a wide array of safety plans and procedures currently in use throughout the Site. All operations and maintenance are governed by existing documentation, or additional plans and procedures are implemented. The procedures include all controls and limits specified in the criticality safety analysis. Procedures are supplemented with posted criticality safety limits if required and clearly designated evacuation routes.

6.5.3 Criticality Safety Training

The nuclear facility manager shall establish a program for selecting, training, and testing individuals and their functional supervisors who handle fissionable material. Training emphasizes that workers must understand and follow applicable safety procedure requirements. All workers handling significant quantities of fissile material (greater than 15 FGE) within nuclear facilities are trained in accordance with the criticality safety training program requirements included in PRD-112. The criticality safety training program meets the requirements of DOE Order 5480.20A[3] and ANSI/ANS 8.20.[4]

6.5.4 Determination of Operational Nuclear Criticality Limits

Operational nuclear criticality limits are established based on the criticality safety principles and criteria, accepted handbook data, criticality safety calculations or evaluations, and criticality safety analyses prescribed in PRD-112 (see Section 6.3). Operational nuclear criticality limits are implemented as TSRs or safety requirements.

6.5.5 Criticality Safety Inspections/Audits

Criticality safety inspections and audits are conducted in accordance with PRD-112.

6.5.6 Criticality Infraction Reporting and Followup

A noncompliance with a criticality safety control is defined as any deviation from safety procedures that may affect the criticality safety or any activity involving fissionable materials. Reporting and followup criticality infractions are reported and documented in accordance with current INEEL procedures and manuals and DOE Order 232.1A.

6.6 Criticality Instrumentation

Based on the results of the analysis for ISV operations, an inadvertent criticality is deemed incredible and no criticality instrumentation is required.

6.7 References

1. DOE Order 232.1A, "Occurrence Reporting and Processing of Operations Information," U.S. Department of Energy, July 27, 1997.

2. DOE Order 420.1A, "Facility Safety," U.S. Department of Energy, May 20, 2002.

3. DOE Order 5480.20A, "Personnel Selection, Qualification, Training Requirements for DOE Nuclear Facilities," U.S. Department of Energy, November 15, 1994.

4. ANSI/ANS 8.20-1991 (R1999) "Nuclear Criticality Safety Training," American National Standards Institute/American Nuclear Society, September 20, 1999.

5. ANSI/ANS 8.1-1998, "Nuclear Criticality Safety in Activities with Fissionable Material Outside Reactors," American National Standards Institute/American Nuclear Society, September 9, 1998.

6. P. J. Sentieri, *Criticality Safety Evaluation for In Situ Vitrification Processing (ISV) at the Radioactive Waste Management Complex at INEEL*, INEEL/EXT-03-00207, Rev. 0, January 2003.

7. PRD-112, "Program Requirement Document for Criticality Safety Program Requirements Manual," *Manual 10B–Engineering and Research,* Rev. 1, June 1, 1998.

7. RADIATION PROTECTION

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7. RADIATION PROTECTION

Chapter 7 of the SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters"[1] describes the Sitewide radiation protection program and contains the information that is generic for all documented safety analyses prepared by the INEEL. Facility/activity-specific radiation protection requirements beyond those described in Chapter 7 of SAR-100 have not been identified.

7.1 Reference

1. SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters," Current revision.

8. HAZARD MATERIAL PROTECTION

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8.1 Reference 8-2

8. HAZARDOUS MATERIAL PROTECTION

Chapter 8 of the SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters"[1] describes the Sitewide hazardous material protection program and contains the information that is generic for all documented safety analyses prepared by the INEEL. Facility/activity-specific hazardous material protection requirements beyond those described in Chapter 8 of SAR-100 have not been identified.

8.1 Reference

1. SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters," Current revision.

9. RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

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9. RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

9.1 Introduction

A waste management program is in place at the INEEL to protect workers, the public, and the environment. This chapter discusses the generation, handling, and disposal of radioactive, mixed, and hazardous waste associated with ISV at the SDA, and the processing of the waste through the INEEL waste management system. This chapter describes how these wastes are managed in accordance with applicable DOE Orders and other Federal, State of Idaho, and local requirements. Because this is a CERCLA-regulated action,[1] only the applicable or relevant and appropriate requirements (ARARs), to-be-considered guidance, and other requirements dictated by a future ISV Record of Decision (ROD) require implementation.

Included in this chapter are descriptions of the following:

- The overall radioactive and hazardous waste management program and organization
- The site-specific radioactive, mixed, and hazardous material waste management policy, objectives, and philosophy
- Identification of hazardous and mixed-waste streams including types and sources
- The waste management process, waste treatment, disposal systems, and administrative controls.

9.2 Requirements

The applicable codes, standards, and DOE orders from which the safety criteria described in this chapter were derived, are identified in the following documents:

- 10 CFR 835, "Occupational Radiation Protection"[2]
- 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants"[3]
- 40 CFR 260, "Hazardous Waste Management System: General"[4]
- 40 CFR 261, "Identification and Listing of Hazardous Waste"[5]
- 40 CFR 262, "Standards Applicable to Generators of Hazardous Waste"[6]
- 40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"[7]
- 40 CFR 268, "Land Disposal Restrictions"[8]
- 40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions"[9]
- DOE Order 435.1, "Radioactive Waste Management"[10]
- DOE Order 460.1A, "Packaging and Transportation Safety"[11]

- DOE Order 5400.1, “General Environmental Protection Program”[12]

- DOE Order 5400.5, “Radiation Protection of the Public and the Environment”[13]

- DOE Order 5480.1B, “Environmental, Safety and Health Program for Department of Energy Operations”[14]

- DOE Order 5484.1, “Environmental Protection, Safety, and Health Protection Information Reporting Requirements”[15]

- State and local requirements.

9.3 Radioactive and Hazardous Waste Management Program and Organization

Management of secondary waste generated as a result of ISV activities is conducted in accordance with a to-be-developed ISV waste management plan (WMP). The WMP is prepared in accordance with DOE orders and defines in detail the planning associated with project waste management including identification and characterization of waste streams, waste management strategies and regulatory considerations, and waste-quantity estimation. The WMP is reviewed by the regulatory agencies responsible for the project under the FFA/CO.[16]

To implement the waste management planning, the applicable INEEL program control documents governing the environmental restoration waste management activities (including related characterization) are followed. A number of downstream documents including PRDs, company policy statements, and, in particular, management control procedures define requirements and procedural implementation of waste management activities.

Applicable procedures define requirements relating to characterization, inspections, labeling, and transportation that are supporting safe and compliant management of waste and are followed for project activities. Training sufficient to comply with 40 CFR 264.16, “Personnel Training,”[17] is required. In addition, the Idaho National Engineering and Environmental Laboratory Waste Acceptance Criteria[18] will apply to any waste processed for storage or disposal at INEEL receiving facilities.

The ISV project and its respective environment, safety, and health group with support from the INEEL Waste Generator Services (WGS) group is responsible for ensuring the ARARs and internal requirements are properly implemented for management of waste generated as a result of ISV activities. Waste reduction requirements and future waste-generation projections are specified in the DOE-ID Interim Pollution Prevention Plan.[19]

9.4 Radioactive and Hazardous Waste Streams or Sources

Only the ISV secondary waste is discussed in this section. The inventory of ISV secondary waste will be discussed in the WMP. Waste expected to be encountered during ISV operations is discussed in Section 3.3.2.1.

9.4.1 Waste Management Process

Secondary and construction waste streams will be placed in interim storage, characterized as necessary, and disposed of under the guidance of WGS personnel. Most secondary and construction waste streams have viable treatment and disposal options. All secondary or construction wastes processed for disposal at the INEEL are subject to compliance with the requirements defined in the INEEL Waste Acceptance Criteria (WAC).[18] While onsite, the waste is managed in accordance with the substantive requirements of the ARARs. Administrative requirements such as timeframes or reporting requirements do not apply to waste in CERCLA storage but may be implemented if required by internal INEEL procedures or may be adopted as best management practices. Generally, where CERCLA waste is shipped off-site (meaning, off the INEEL site) to a treatment, storage, or disposal facility (TSDF), the waste must comply with all applicable regulatory requirements (administrative and substantive) including compliance with the CERCLA off-site rule (40 CFR 300.440, "Procedures for Planning and Implementing Off-Site Response Actions").[20]

9.4.1.1 Storage and Disposal. Storage locations will be established for temporary storage of secondary and construction waste. All on-site storage locations will be subject to substantive ARARs that apply to a CERCLA storage area.

Container storage areas and containers for collection of waste are clearly labeled to identify waste type. Waste will generally be segregated in accordance with waste category and type. Segregation by waste category primarily entails designation (by posting signs) of separate areas within the CERCLA storage area for secondary waste. Segregation by source of contamination entails separation of mixed waste, TRU, LLW, and hazardous-waste streams within containers and within the storage area. In addition, segregation of waste zone materials to address issues related to incompatible chemicals will occur if necessary. These waste streams are planned for disposal following interim onsite storage and characterization, as necessary.

9.4.1.2 Management of Mixed Waste. Mixed waste generated during ISV activities is managed in accordance with the ARARs for waste management. Mixed waste will be stored in the CERCLA storage area in accordance with the hazardous waste determinations (HWDs) and in compliance with ARARs. The waste will be evaluated for disposal at INEEL facilities.

9.4.1.3 Management of Low-Level Waste. Low-level waste generated during project activities is evaluated against the INEEL WAC and the INEEL CERCLA Disposal Facility (ICDF) WAC.[21] Evaluation of waste may involve sampling and analysis or process knowledge. While in on-site CERCLA storage, the waste is stored in accordance with the substantive requirements of the ARARs of an ISV ROD, and in accordance with applicable INEEL procedures for radioactive waste material storage.

9.4.1.4 Management of Transuranic Waste. Generation of TRU waste from ISV activities is not anticipated. The absence of TRU waste generation eliminates the need to manage TRU waste.

9.4.1.5 Management of Hazardous Waste. Little to no hazardous waste will be generated as a result of ISV activities. If hazardous waste is generated, the waste will be characterized, packaged, and stored in accordance with the substantive requirements of RCRA until final disposition in accordance with the INEEL WAC and company procedures.

9.4.2 Waste Sources and Characteristics

The waste streams associated with project activities are defined in the following two categories:

- **Secondary waste:** A generic category for waste that is generated from support activities (including operations and maintenance activities) related to ISV processing. Examples of secondary waste include waste associated with routine decontamination activities and PPE, administrative area and support service waste, used equipment and filters, and other similar waste generated during operations and maintenance activities

- **Construction waste:** Waste generated during the on-site construction of project facilities and equipment.

9.4.2.1 Sources of Mixed Waste. The following activities may result in the generation of mixed wastes. For each application of ISV, a small amount of sample waste and decontamination waste is generated. Filters are used in several locations to control airborne releases from the various facilities (from such sources as HEPA filtration of discharge air leaving the off-gas system). In some instances, maintenance activities will require decontamination of equipment before performing the maintenance work. Additionally, maintenance personnel are required to wear protective clothing and respiratory protection as specified in radiation and safety work permits. Details of this decontamination are not currently defined. However, such activities could lead to the generation of PPE, solid (rags), and liquid waste.

Spills of various materials could occur during operational activities. The primary spills that could occur include spills from the glycol cooling system, hydraulic oil spills and leaks from support equipment, and spills associated with filling of the diesel tank supporting the standby power generator.

Waste associated with decontamination and decommissioning (D&D) of the ISV equipment may require management as mixed waste. Examples of waste streams include PPE, structural components, and materials used during D&D (such as rags and survey waste).

9.4.2.2 Sources of Low-Level Waste. Solid LLW may be generated as a result of ISV operational activities (such as, HEPA filter changeouts), and other associated activities. All activities involving radioactive waste are conducted under the surveillance of radiological control technicians (RCTs) who may use various types of materials such as large-area wipes to perform routine surveys for radioactive contamination. If the wipes are not contaminated, they are ultimately disposed of as LLW. Other LLW also may be generated from these activities (including PPE such as gloves, booties, respirator cartridges, and other protective clothing).

The HEPA filters used in the off-gas system will require periodic changeout. If a HEPA filter is determined to be contaminated after RCT surveillance or sampling and analysis, it may be disposed of as LLW as long as it does not come into contact with hazardous waste contaminants or is not classified as TRU waste. Replacing HEPA filters also may generate other types of LLW including plastic sheeting, tape, RCT surveillance materials, blotter paper, and PPE.

9.4.2.3 Sources of Transuranic Waste. Generation of TRU waste is not anticipated as a result of ISV activities.

9.4.2.4 Sources of Hazardous Waste. Little to no hazardous waste is generated as a result of ISV activities. However, if RCRA-regulated hazardous waste is generated from ISV maintenance or operational activities, the waste can be stored in the CERCLA storage area pending processing in accordance with the INEEL WAC.

9.4.3 Waste Handling or Treatment Systems

9.4.3.1 Treatment of Mixed Waste. Mixed waste generated as a result of ISV activities is evaluated for disposal at INEEL facilities.

9.4.3.2 Treatment of Low-Level Waste. The LLW that is generated during project processes is managed in accordance with the INEEL WAC including the ICDF WAC.

9.4.3.3 Treatment of Transuranic Waste. Generation of TRU waste from ISV activities is not anticipated. The absence of TRU waste generation eliminates the need to treat TRU waste.

9.4.3.4 Treatment of Hazardous Waste. Treatment of hazardous waste generated during project activities can be conducted at a permitted TSDF. Waste Generator Services personnel will arrange waste approval and transportation-related activities to the permitted TSDF.

9.4.4 Normal Emissions

Normal releases are analyzed in an air-emissions evaluation. The emissions evaluation calculates the radioactive material and nonradioactive material air pollutant atmospheric emissions and performs air dispersion and dose assessment modeling to determine compliance with "National Emissions Standards for Hazardous Air Pollutants,"[22] "State of Idaho Toxic Air Pollutant (TAP) Regulations,"[23] worker occupational exposure levels, and short-term risk.

9.5 References

1. 42 USC 9601 et seq., "Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA/Superfund)," *United States Code*, 1980.

2. 10 CFR 835, Occupational Radiation Protection," *Code of Federal Regulations,* Office of the Federal Register, April 2, 2002.

3. 40 CFR 61, "National Emissions Standards for Hazardous Air Pollutants," *Code of Federal Regulations*, Office of the Federal Register, April 8, 2003.

4. 40 CFR 260, "Hazardous Waste Management System: General," *Code of Federal Regulations,* Office of the Federal Register, April 2002.

5. 40 CFR 261, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations*, Office of the Federal Register, August 2002.

6. 40 CFR 262, "Standards Applicable to Generators of Hazardous Waste," *Code of Federal Regulations*, Office of the Federal Register, February 2002.

7. 40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*, Office of the Federal Register, April 2002.

8. 40 CFR 268, "Land Disposal Restrictions," *Code of Federal Regulations*, Office of the Federal Register, October 2002.

9. 40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," *Code of Federal Regulations*, Office of the Federal Register, February 2002.

10. DOE Order 435.1, "Radioactive Waste Management," U.S. Department of Energy, July 9, 1999 (including Change 1, August 28, 2001).

11. DOE Order 460.1A, "Packaging and Transportation Safety," U.S. Department of Energy, October 2, 1996.

12. DOE Order 5400.1, "General Environmental Protection Program," U.S. Department of Energy, November 9, 1988 (including Change 1, June 29, 1990). (Note: Specific paragraphs cancelled by DOE Order 231.1, "Environmental, Safety, and Health Reporting," including Change 2, November 11, 1996.)

13. DOE Order 5400.5, "Radiation Protection of the Public and the Environment," U.S. Department of Energy, February 8, 1990 (including Change 2, January 7, 1993).

14. DOE Order 5480.1B, "Environmental, Safety, and Health Program for Department of Energy Operations," U.S. Department of Energy, September 23, 1986.

15. DOE Order 5484.1, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements," U.S. Department of Energy, including Change 7, October 17, 1990.

16. DOE-ID, *Action Plan for Implementation of the Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory,* Administrative Record No. 1088-06-29-120, U.S. Department of Energy Idaho Operations Office; U.S. Environmental Protection Agency, Region 10; Idaho Department of Health and Welfare, December 1991.

17. 40 CFR 264.16, "Personnel Training," *Code of Federal Regulations*, Office of the Federal Register, April 2002.

18. DOE-ID, *Idaho National Engineering and Environmental Laboratory Waste Acceptance Criteria,* DOE/ID-01-10381, U.S. Department of Energy Idaho Operations Office, Rev. 14, September 2002.

19. D. H. Janke, *U.S. Department of Energy — Idaho Operations Office, Idaho National Engineering and Environmental Laboratory Interim Pollution Prevention Plan,* DOE/ID-10333(00), U.S. Department of Energy Idaho Operations Office, 2000.

20. 40 CFR 300.440, "Procedures for Planning and Implementing Off-Site Response Actions," *Code of Federal Regulations*, Office of the Federal Register, October 2002.

21. DOE-ID, *Waste Acceptance Criteria (WAC) for INEEL CERCLA Disposal Facility (ICDF) Landfill (Draft Final Title II) – ICDF 90% Design Package – Appendix P to Remedial Design Construction Workplan (RD/CWP) – Included in Volume 3 of 5, Design Analyses (Draft)*, DOE/ID-10865, U.S. Department of Energy Idaho Operations Office, June 2002.

22. 40 CFR 61, "National Emissions Standards for Hazardous Air Pollutants," *Code of Federal Regulations*, Office of the Federal Register, February 4, 2002.

23. IDAPA 58.01.01.585, .586, "Rules for the Control of Air Pollution in Idaho," Idaho State Regulations, March 15, 2002.

10. INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

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10.1 Reference 10-2

10. INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

Chapter 10 of the SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters"[1] contains the information that is generic for all DSAs prepared by the INEEL. Facility/activity-specific requirements beyond those described in Chapter 10 of SAR-100 have not been identified.

10.1 Reference

1. SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters," Current revision.

11. OPERATIONAL SAFETY

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11. OPERATIONAL SAFETY 11-2

11.1 References 11-2

11. OPERATIONAL SAFETY

Chapter 11 of the SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters"[1] contains the information that is generic for all DSAs prepared by the INEEL. Chapter 11 describes the sitewide operational safety programs, which are applicable to ISV at the SDA, and includes the design codes, standards, regulations, and DOE Orders which are required for establishing the safety basis of ISV at the SDA as well as elements of the conduct of operations program. Facility/activity-specific operational safety requirements beyond those described in Chapter 11 of SAR-100 will be identified in the facility fire hazard analysis (FHA) that is required by DOE Order 420.1A.[2] An FHA has not been prepared for the preliminary DSA but will be prepared for the final DSA for ISV at the SDA. The following limitations have been identified and should be evaluated in the FHA:

1. Assess water supply provisions that are required to support fire department manual suppression activities at an ISV site within the SDA

2. Assess necessary controls to minimize the potential for a fuel-air explosion in the off-gas hood and off-gas treatment system

3. Assess the potential for underground fire propagation.

Even though ISV operations are conducted in accordance with the provisions of applicable building/fire codes and standards such as NFPA 801,[3] fire is recognized as a primary hazard in the hazard/accident analysis presented in Section 3.

Consistent with a graded approach, not all fire hazards are identified. Only those fire scenarios considered to have a high potential for adverse impact on the radioactive materials or the ISV equipment, or to present an unusual threat have been analyzed. Nitration reaction and mixtures with free flammable or combustible liquids may have increased the flammability of the combustible materials in the SDA. Combustible liquids (mainly oils in both damaged and intact containers) are expected. Pyrophoric metals that could be fire initiators are present in the SDA. Hydrogen generation because of the radiolysis of waste zone materials is expected. However, because of the deteriorated condition of waste containers in the retrieval area, the risk of a hydrogen explosion is very low.

The identified fire hazards include a fire involving the radioactive and nonradioactive hazardous materials in the treatment area and the off-gases generated by ISV processing. The accident analysis addresses the risk from fire causing a release of the radioactive and nonradioactive hazardous materials. Section 3 considers underground fires, fires in the off-gas hood surface, and fires initiated by an electrical panel failure, by maintenance activities such as welding, by range fires, and by lightning. The potential for a fire during ISV operations is assumed to be anticipated based on the occurrence of fires occurring over the operating history of ISV.

11.1 References

1. SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters," Current revision.

2. DOE Order 420.1A, "Facility Safety," U.S. Department of Energy, May 20, 2002.

3. NFPA 801, "Standard for Fire Protection for Facilities Handling Radioactive Materials," National Fire Protection Association, February 6, 1998.

12. PROCEDURES AND TRAINING

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12. PROCEDURES AND TRAINING 12-2

12.1 Reference 12-2

12. PROCEDURES AND TRAINING

Chapter 12 of the SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters"[1] contains the information that is generic for all DSAs prepared by the INEEL. Facility/activity-specific requirements beyond those described in Chapter 12 of SAR-100 have not been identified.

12.1 Reference

1. SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters," Current revision.

13. HUMAN FACTORS

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13. HUMAN FACTORS

Chapter 13 of the SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters"[1] contains the information that is generic for all DSAs prepared by the INEEL. This chapter focuses on human factors engineering and the importance of the design of ISV equipment to optimize human performance. The emphasis is on human-machine interfaces required for ensuring the safety function of safety SSCs discussed in Chapter 4 and on the provisions made for optimizing the design of those human-machine interfaces to enhance reliable performance.

13.1 Requirements

The requirements that apply to human factors engineering are contained in the following documents:

- 10 CFR 830, Subpart B, "Safety Basis Requirements"[2]
- DOE Order 420.1A, "Facility Safety"[3]
- DOE-STD-3009-94, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses."[4]

13.2 Human Factors Process

Human factors activities are performed through the detailed design activities. At the early stage in the design, the primary objective of human factors is to ensure that the area layouts, equipment designs, and equipment operations are free from potential hazards to personnel and dangers to facility safety.

A human error analysis of operations would be performed by Training and Human Factors staff in the context of the project operations team. The goal of this analysis would be to identify error likely situations, the error precursors (performance shaping factors), and recovery factors. This analysis would be used to improve procedures, training and general operational awareness. The team would consist of operations personnel, procedure writers, training personnel, and operations management. All team personnel would be available as subject matter experts for the analysis.

13.3 Identification of Human-to-Machine Interfaces

The off-gas treatment system has been identified as a safety-class system and is the only system that requires human action for performance of the safety function. The off-gas treatment system includes the primary and secondary off-gas ventilation systems and the combustible gas monitors.

13.4 Optimizing Human-to-Machine Interfaces

The function of the off-gas treatment system is to treat off-gases generated by ISV processing. The primary and secondary off-gas ventilation systems prevent the build up of off-gases while the combustible gas monitoring system warns of dangerous concentrations of combustible gases in the system. A human factors evaluation would identify areas of the design that could enhance performance of the safety function.

13.5 References

1. SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters," Current revision.

2. 10 CFR 830 Subpart B, Subpart B, "Safety Basis Requirements," *Code of Federal Regulations*, Office of the Federal Register, February 2002.

3. DOE Order 420.1A, "Facility Safety," U.S. Department of Energy, May 20, 2002.

4. DOE-STD-3009-94, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports," U.S. Department of Energy, July 1994 (including Change 2, April 2002).

14. QUALITY ASSURANCE

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14. QUALITY ASSURANCE 14-2

    14.1 Reference 14-2

14. QUALITY ASSURANCE

Chapter 14 of the SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters"[1] contains the information that is generic for all DSAs prepared by the INEEL. Facility/activity-specific requirements beyond those described in Chapter 14 of SAR-100 have not been identified.

14.1 Reference

1. SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters," Current revision.

15. EMERGENCY PREPAREDNESS PROGRAM

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15. EMERGENCY PREPAREDNESS PROGRAM 15-2

15.1 Reference 15-2

15. EMERGENCY PREPAREDNESS PROGRAM

Chapter 15 of the SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters"[1] contains the information that is generic for all DSAs prepared by the INEEL. Facility/activity-specific requirements beyond those described in Chapter 15 of SAR-100 have not been identified.

15.1 Reference

1. SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters," Current revision.

16. PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

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16. PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING 16-2

16.1 Reference 16-2

16. PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

Chapter 16 of the SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters"[1] contains the information that is generic for all DSAs prepared by the INEEL. Facility/activity-specific requirements beyond those described in Chapter 16 of SAR-100 have not been identified.

16.1 Reference

1. SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters," Current revision.

17. MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS

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17. MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS 17-2

17.1 References 17-2

17. MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL SAFETY PROVISIONS

Chapter 17 of the SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters"[1] contains the information that is generic for all DSAs prepared by the INEEL and describes the Sitewide management, organization, and institutional safety provisions, which are applicable to ISV processing at the SDA. Facility activity-specific management, organization, and institutional safety provisions pertaining to RWMC are described in Chapter 17 of the RWMC SAR.[2] Facility/activity-specific requirements beyond those described in Chapter 17 of SAR-100 and Chapter 17 of the RWMC SAR have not been identified.

17.1 References

1. SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters," Current revision.

2. INEEL, *Radioactive Waste Management Complex Safety Analysis Report*, INEEL-94/0226, Rev. 5, October 20, 2000.

Appendix A

Idaho National Engineering and Environmental Laboratory Risk Evaluation Guidelines

Appendix A

Idaho National Engineering and Environmental Laboratory Risk Evaluation Guidelines

The following evaluation guidelines are from DOE-ID Order 420.D, "Requirements and Guidance for Safety Analysis."[1]

Table A-1. Idaho National Engineering and Environmental Laboratory off-site radiation dose evaluation guidelines.

Frequency Category	Occurrence Frequency (F) (per year)	Off-Site[a] Radiation Consequences
Anticipated	F > 1E-02	0.5 rem TEDE
Unlikely	1E-02 ≥ F > 1E-04	5.0 rem TEDE
Extremely unlikely	1E-04 ≥ F > 1E-06	25 rem TEDE

a. Off-site is defined as a member of the public at the nearest INEEL site boundary, which is 6 km for the RWMC.

TEDE total effective dose equivalent

Table A-2. Idaho National Engineering and Environmental Laboratory on-Site radiation dose evaluation guidelines.

Frequency Category	Occurrence Frequency (F) (per year)	On-Site[a] Radiation Consequences
Anticipated	F > 1E-02	5 rem TEDE
Unlikely	1E-02 ≥ F > 1E-04	25 rem TEDE
Extremely unlikely	1E-04 ≥ F > 1E-06	100 rem TEDE

a. On-site includes facility workers and co-located workers. The co-located worker is assumed to be located 100 m from releases. Facility workers are assumed to be directly exposed at the point of release.

TEDE total effective dose equivalent

Table A-3. INEEL nonradioactive hazardous material evaluation guidelines.

Frequency Category	Occurrence Frequency (F) (per year)	On-Site Consequences	Off-Site Consequences
Anticipated	F > 1E-02	≤ERPG-1 or equivalent	≤TLV-TWA
Unlikely	1E-02 ≥ F > 1E-04	≤ERPG-2 or equivalent	≤ERPG-1 or equivalent
Extremely unlikely	1E-04 ≥ F > 1E-06	≤ERPG-3 or equivalent[a]	≤ERPG-2 or equivalent

a. Only for co-located workers, not facility workers.

ERPG Emergency Response Planning Guide
F occurrence frequency
TLV threshold limit value
TWA time-weighted average

Table A-4. Emergency response planning guidelines,[a] temporary emergency exposure limits,[a] and threshold limit value—time-weighted average[b] for determining acceptable toxicological consequences.

Substance	TLV-TWA or TEEL-0 (mg/m^3)	ERPG-1 or TEEL-1 (mg/m^3)	ERPG-2 or TEEL-2 (mg/m^3)	ERPG-3 or TEEL-3 (mg/m^3)
1,1,1-trichloroethane	1,910	1,925	3,850	19,250
1,1,2-trichloro-1,2,2-trifluoroethane	7,665	10,000	10,000	15,000
2-butanone	590	750	750	7,500
Acetone	1,187	2,000	20,000	20,000
Aluminum nitrate nonahydrate	25	25	125	500
Ammonia	17	17.5	105	525
Anthracene	2	6	40	150
Antimony	0.5	1.5	25	50
Aqua regia	0.75	4	30	150
Arsenic	0.01	1.5	2.5	350
Asbestos	0.005	0.5	0.5	2.5
Barium	0.5	1.5	25	125
Benzine	1,399	1,250	1,500	1,500
Beryllium	0.002	0.005	0.025	0.1
Butyl alcohol	61	150	150	4,000
Cadmium	0.002	0.03	0.5	7.5
Carbon tetrachloride	31	128	639	4,790
Cerium chloride	7.5	25	150	500
Chloroform	49	10	248	24,800
Chromium	0.01	1.5	2.5	250
Copper	0.2	3	5	100
Copper nitrate	3	7.5	60	300
Ethyl alcohol	1,884	5,000	6,000	6,000
Formaldehyde	0.3	1.25	12.5	30
Hydrazine	0.013	0.7	6.6	40
Hydrofluoric acid	2.5	1.5	16.4	41
Lead	0.05	0.15	0.25	100
Magnesium	10	30	50	250
Magnesium fluoride	4	12.5	20	400

Table A-4. (continued).

Substance	TLV-TWA or TEEL-0 (mg/m^3)	ERPG-1 or TEEL-1 (mg/m^3)	ERPG-2 or TEEL-2 (mg/m^3)	ERPG-3 or TEEL-3 (mg/m^3)
Mercury	0.025	0.1	2.05	4.1
Mercury nitrate monohydrate	0.04	0.15	0.15	15
Methyl alcohol	262	262	1,308	6,540
Methyl isobutyl ketone	205	300	1,000	2,000
Methylene chloride	174	696	2,610	13,920
Nickel	1.5	4.5	10	10
Nitric acid	5.2	3	15	200
Potassium chloride	1.5	5	15	15
Potassium dichromate	0.125	0.25	2.5	40
Potassium nitrate	1	3.5	20	500
Potassium phosphate	10	30	50	500
Potassium sulfate	2	6	40	500
Silver	0.01	0.3	0.5	10
Sodium	0.5	0.5	5	50
Sodium chloride	15	40	300	500
Sodium cyanide	5	5	5	40
Sodium dichromate	0.125	0.25	25	35
Sodium hydroxide	2	0.5	5	50
Sodium nitrate	0.4	1	7.5	100
Sodium phosphate	10	30	50	500
Sodium potassium	0.5	0.5	5	50
Sodium sulfate	10	30	500	500
Sulfuric acid	1	2	10	30
Terphenyl	5	5	9	500
Tetrachloroethylene	170	689	1,378	6,890
Toluene	188	188	1,125	3,750
Tributyl phosphate	2.2	6	10	300
Trichloroethylene	269	538	2,690	26,900
Trimethylolpropane-triester	N/A	N/A	N/A	N/A
Uranium	0.2	0.6	1	10
Uranyl nitrate	0.075	1	1	15
Versenes (EDTA)	1.25	4	30	150
Xylene	434	600	750	4,000
Zirconium	5	10	10	50
Zirconium alloys	5	10	10	50
Zirconium oxide	6	12.5	12.5	60
Hydrochloric Acid	3	4.5	30	224
Phosgene	0.4	0.4	0.8	4

A1. REFERENCES

1. DOE-ID Order 420.D, "Requirements and Guidance for Safety Analysis," U.S. Department of Energy Idaho Operations Office, July 17, 2000.

2. DOE, ERPGs and TEELs for Chemicals of Concern, http://tis.eh.doe.gov/web/chem_safety/teel.html, Web page updated December 10, 2002, Web page visited April 24, 2003.

3. ACGIH, *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*, American Conference of Governmental Industrial Hygienists, 2002.